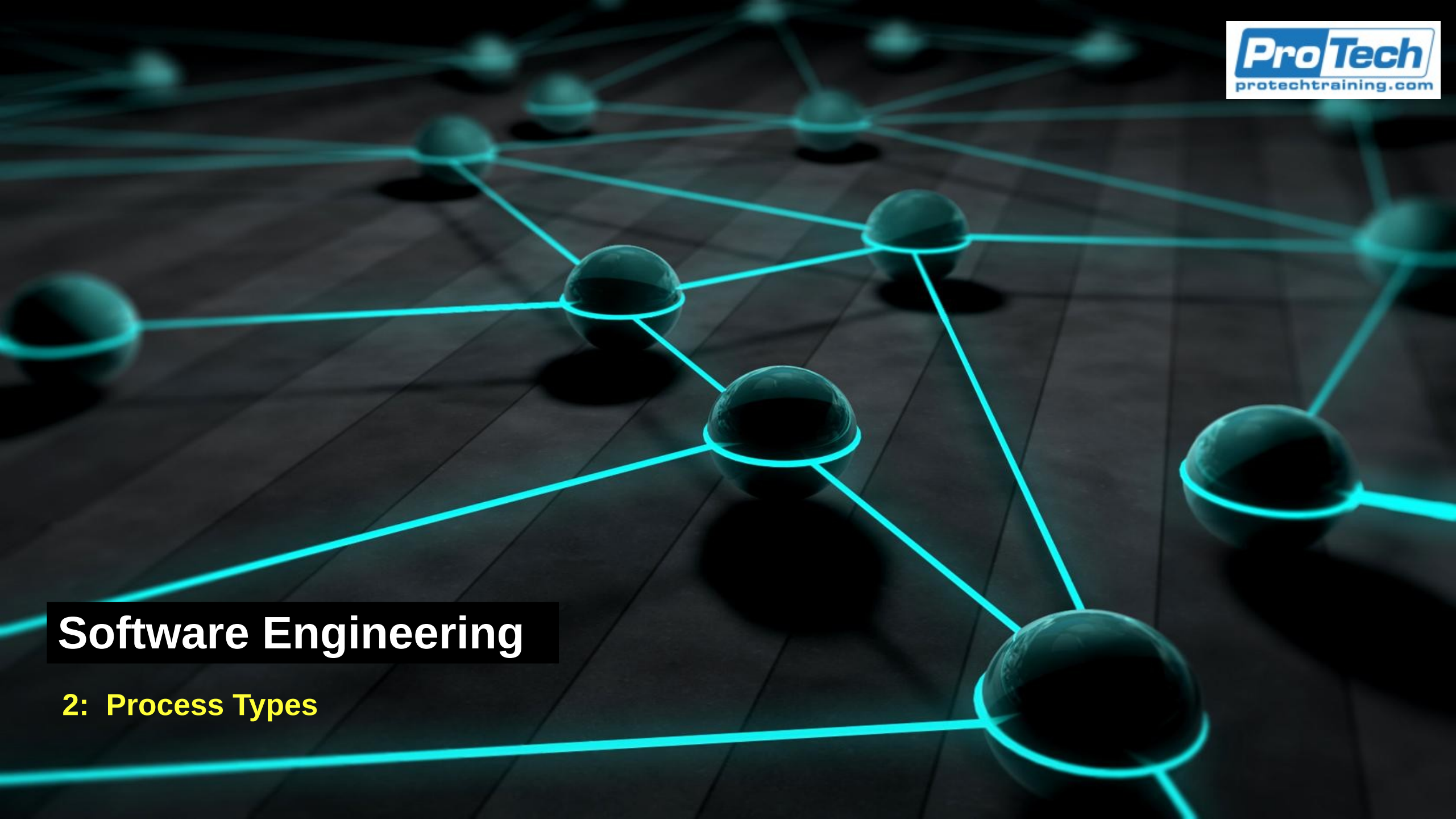
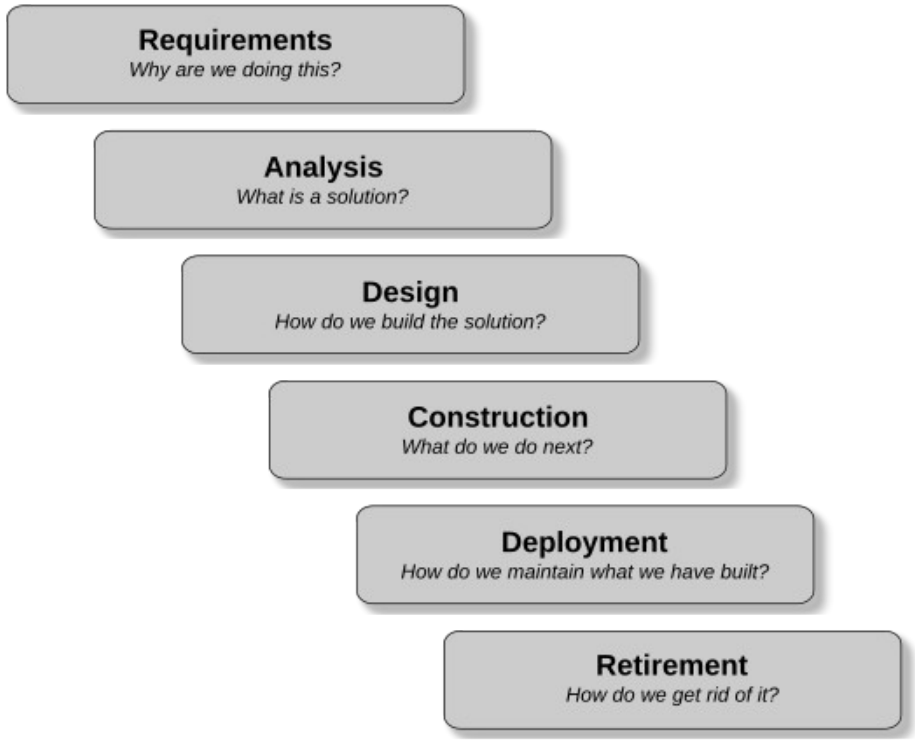


Software Engineering

2: Process Types

The Engineering Cycle

- The Engineering Cycle is a set of logical steps
  - Each step builds on the previous one
  - How we apply this cycle is a process type.
- Waterfall Process
  - Characterized by completing each step in the process before moving on to the next.
  - Also called a predictive process because given the full set of requirements and technical constraints, we can accurately predict the outcome.
  - Common in engineering systems and high risk systems
    - Like nuclear reactor control software or airline navigation software
  - Or where requirements and technology doesn't change over the lifetime of the project



Real Life

- For a lot of applications, the waterfall doesn't work
  - Due to uncertainty and variation at each stake of the engineering cycle
  - Can create a lot of rework
- Manufacturing started to experiment in 1950s-1980s
  - Very influential innovation: Lean manufacturing & Toyota production system
- In the 1980s, there was a major crisis in software development
  - At the time, most software was being developed waterfall (big bang) style
  - Siloed teams (design, development, testing) with one-time hand offs of artifacts
  - Same issues addressed in the NATO 1969 conference
  - Recommended adopting the lean, iterative and incremental approaches being used in manufacturing

Adaptive Methodologies

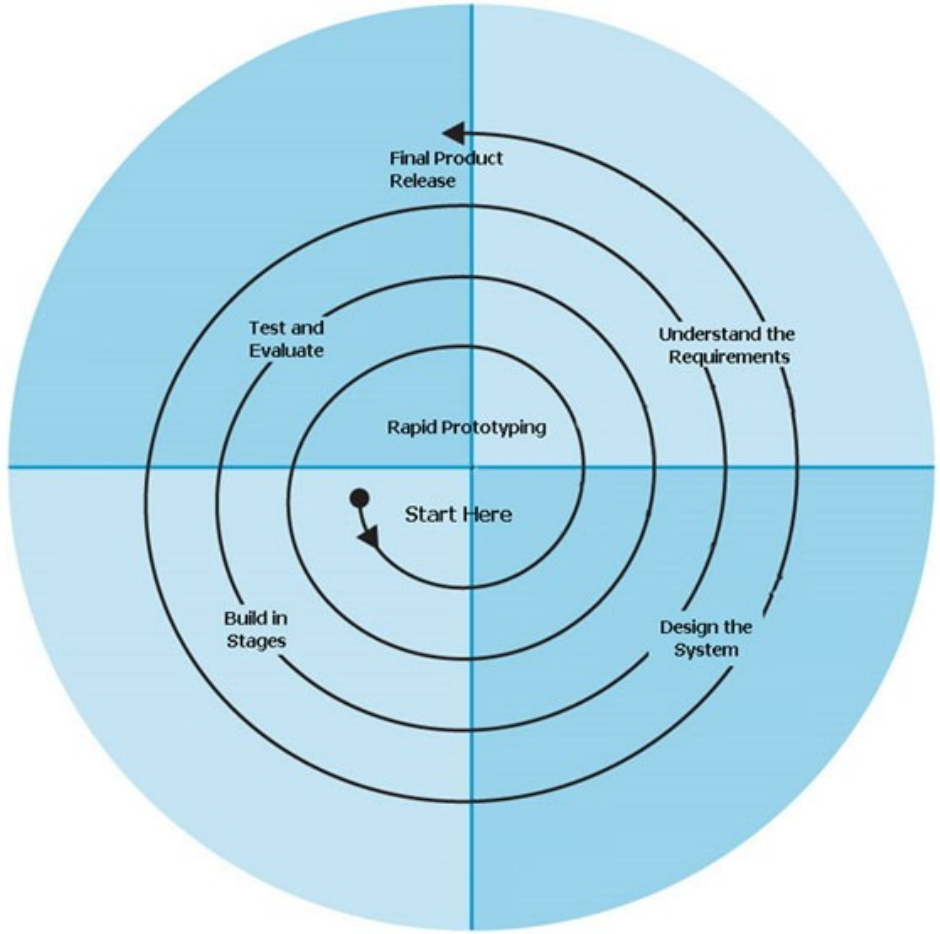
- In the 1980s and 1990s
  - Companies experimented with using what they called adaptive approaches
  - IBM, DuPont, and others experimented with iterative prototyping and empirical process control.
  - Derived from the work mentioned in the previous slide and others (especially lean)
- Characterized by
  - Use of successive prototypes to get feedback on requirements, design and performance
  - Short iterations (one month or less),
  - Cross-functional teams,
  - Daily meetings for synchronization,
  - A prioritized feature list

SCRUM

- The term Scrum is first used in 1986 with reference to new product development
  - Hirotaka Takeuchi and Ikujiro Nonaka “The New New Product Development Game”
  - Not originally developed for software
  - Jeff Sutherland & Ken Schwaber (1997) Presented the first public paper on Scrum: "SCRUM Development Process" adapting it to software development
- Emphasized:
  - Empirical process control theory (transparency, inspection, adaptation),
  - Lean principles,
  - Nonaka & Takeuchi’s knowledge-creation theory (SECI) – the basis for cross functional teams
- The basic ideas expressed in Scrum started to be adopted
  - Primarily by teams working with highly adaptive types of projects
  - Often smaller teams of developers working closely with the business side

Non-Agile Adaptive Methodologies

- Influences on Agile were some of the adaptive methods used in computer engineering
  - Barry Boehm's Spiral methodology from 1986 defined a series of iterations with the objective of producing prototypes which were used to provide inputs into the subsequent iterations.
  - Another adaptive methodology is James Martin's Rapid Application Development (RAD) developed in the 1980s at IBM.
- Both SDLCs was built around the idea that for some sorts of development, like working with user interfaces, the requirements are too fluid for a predictive approach.
- The RAD approach, like the Spiral methodology, centered around getting a prototype into the hands of the users to start generating feedback that would be used to continuously develop the product



http://softwaretesting-qaqc.blogspot.com

Scrum and Agile

- Agile was the general term adopted in 2001
  - By a consortium of owners of adaptive methodologies that shared a similar approach to development derived from their use of Scrum ideas
  - eg. Extreme Programming, Feature Driven Development
  - As a result, many of the features of Scrum were incorporated into the Agile Manifest and the Agile Principles
- Note that Scrum is NOT an Agile methodology, but its concepts were shared among Agile methodology
  - Specifically:
    - Individuals and interactions over formal documentation
    - Working software prototypes
    - Customer collaboration and feedback loops
    - Responding to change.

Agile Principles

- The various Agile methodologies summarized their approach to building software through a statement of Agile principles:
  - Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
  - We welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
  - Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
  - Business people and developers must work together daily throughout the project.
  - Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
  - The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
  - Working software is the primary measure of progress.
  - Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace

Agile Principles

  - Continuous attention to technical excellence and good design enhances agility.
  - Simplicity--the art of maximizing the amount of work not done--is essential.
  - The best architectures, requirements, and designs emerge from self-organizing teams.
  - At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

- Note that Agile principles are about how we organize our development process
  - It does NOT address programming issues or how we write our code
  - The is up to the individual methodology, for example, Extreme Programming (XP)

Extreme Programming (XP)

- Example of a development methodology that defines the actual programming practices to complement the process
- Many modern programming techniques originated in a methodology called Extreme Programming or XP
  - Created by Kent Beck.
  - XP is extreme means taking 12 development "best practices" to their logical extremes
- XP is intended to be easily used for projects of up to a dozen programmers and twice that with some difficulty
  - XP itself does not scale well
  - The way to do large scale XP development is within a project organized overall along more traditional models, but is then split into multiple smaller XP projects

Extreme Programming (XP)

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- Many modern programming techniques originated in a methodology called Extreme Programming or XP
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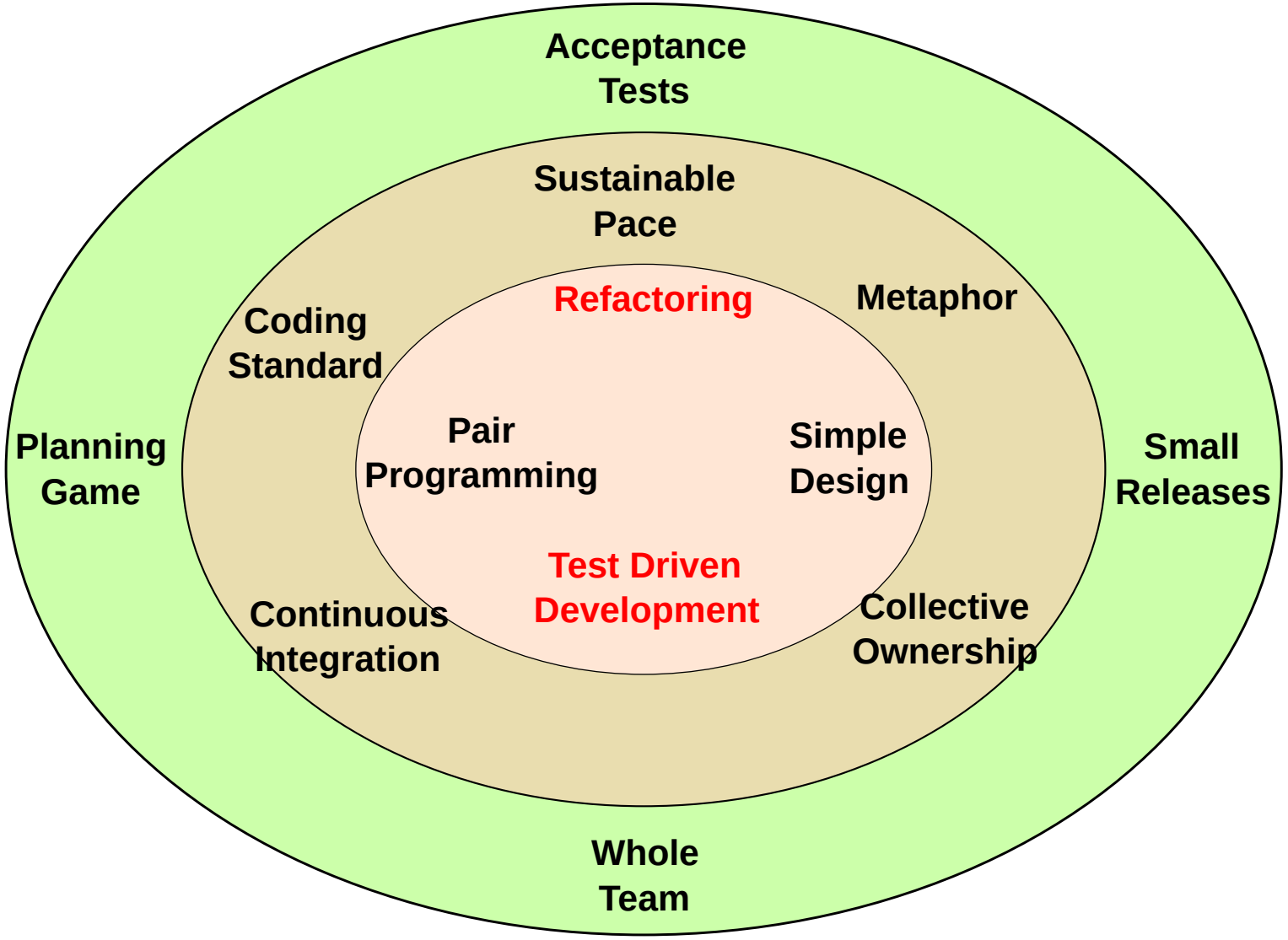
  - Saying XP is extreme means taking 12 development "best practices" to their logical extremes
- Organized the specific activities to be used in programming
  - Designed so that the programming practice could easily map into the development process
- Organized these into the XP onion
  - Many have these have been adopted as software engineering best practices

Xp Onion


Acceptance
Tests
Sustainable
Pace
Refactoring
Metaphor
Coding
Standard
Planning
Game
Pair
Programming
Simple
Design
Small
Releases
Test Driven
Development
Continuous
Integration
Collective
Ownership
Whole
Team

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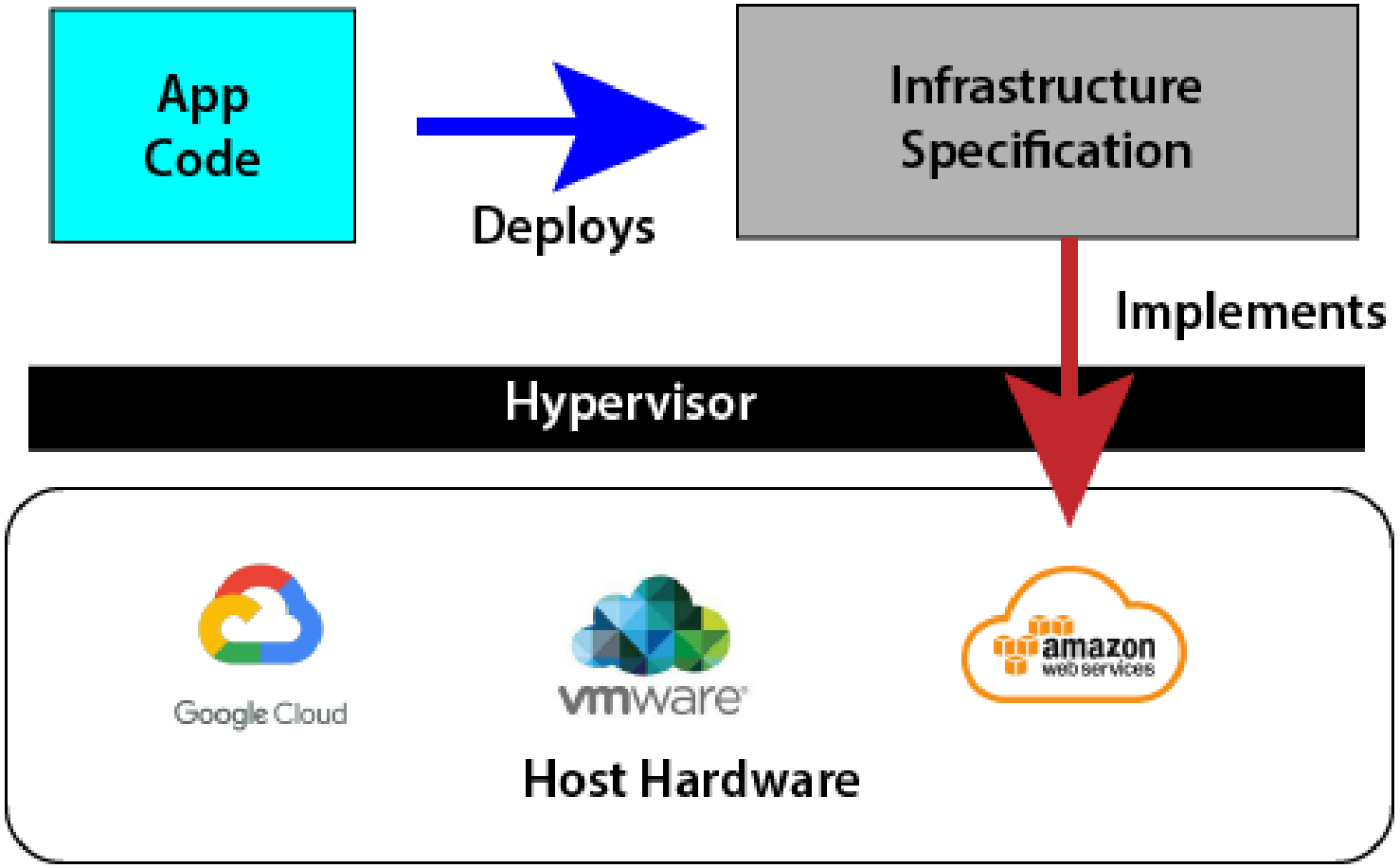
Infrastructure as Code

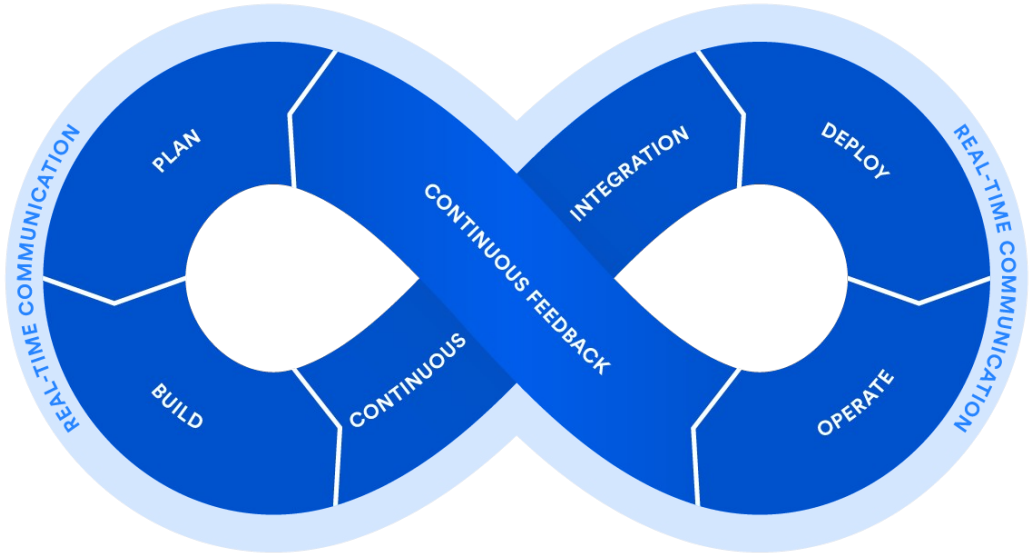
- With the increase in hardware capability, hardware was not being used to its capacity
  - Running multiple virtual machines on a single hardware host solved the problem
  - The different VMs would talk to a hypervisor that would be responsible for allocating hardware to the virtual machine.
  - This is how a VM is created in the cloud.
- This meant that provisioning an operational environment
  - Did not mean working with hardware directly
  - But we wrote a specification or set of instructions to the hypervisor
  - The spec tells the hypervisor what virtual hardware to set up
  - The hypervisor does the hardware allocation
  - Writing this specification became called “infrastructure as code”

Infrastructure as Code



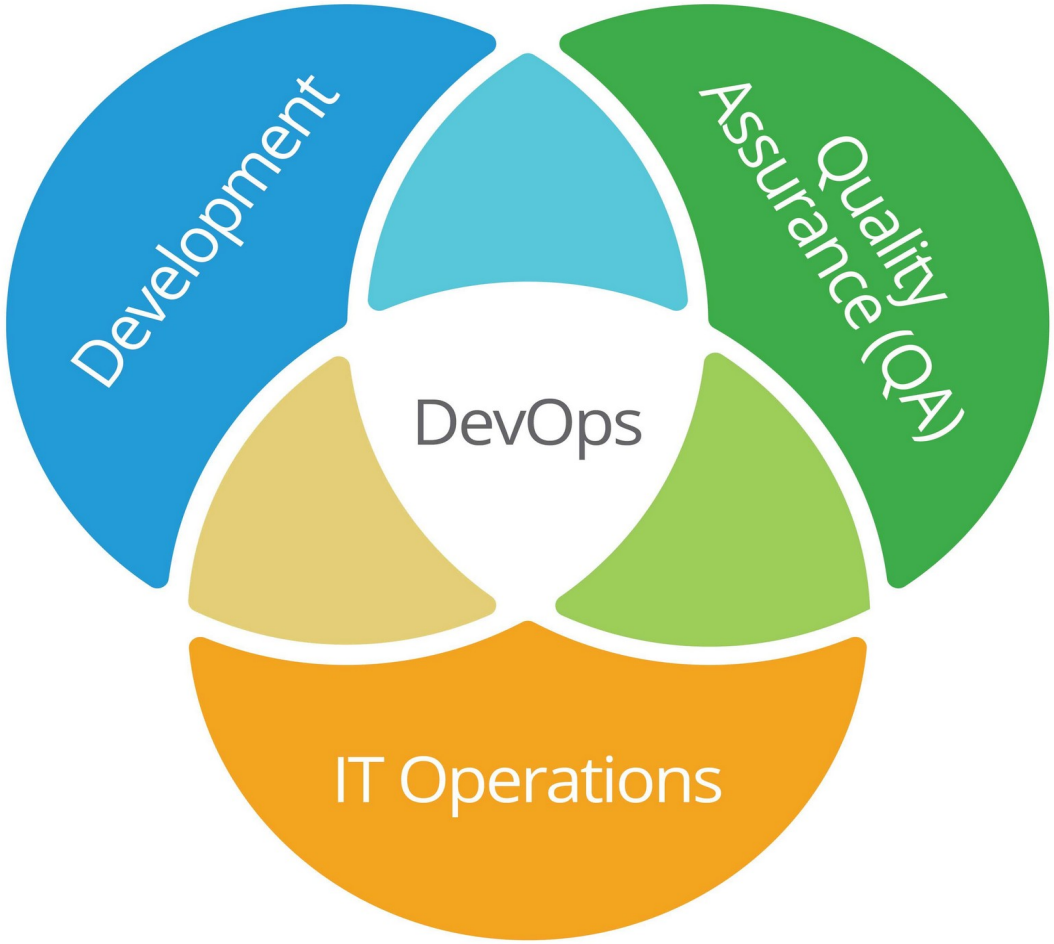
DevOps

- Driven by virtualization and Infrastructure as code
  - Dev and Ops had been two separate worlds
  - Dev was sort of automated
  - Ops was manual and bare metal
- Virtualization turned it all into code
  - Now the same tools can be used in the entire life cycle of a software product
  - Opportunity for full process automation support
- And it allowed the integration of the engineering deployment phase to be integrated into software engineering



The Goal of DevOps

- Desilo-ize the three areas in software development
- Get everyone using the same sorts of tools, practices and automation



Defining CICD

- CICD is not a methodology
  - It is not Agile or DevOps
  - Although both rely on CICD and use it extensively
- CICD is process automation applied to SE
  - It is not Agile or DevOps
  - Similar to other kinds of automation
  - Improves process efficiency and effectiveness
- CICD is process agnostic
  - Can be used anywhere a SE process is well defined
  - Using CICD with bad processes makes them worse

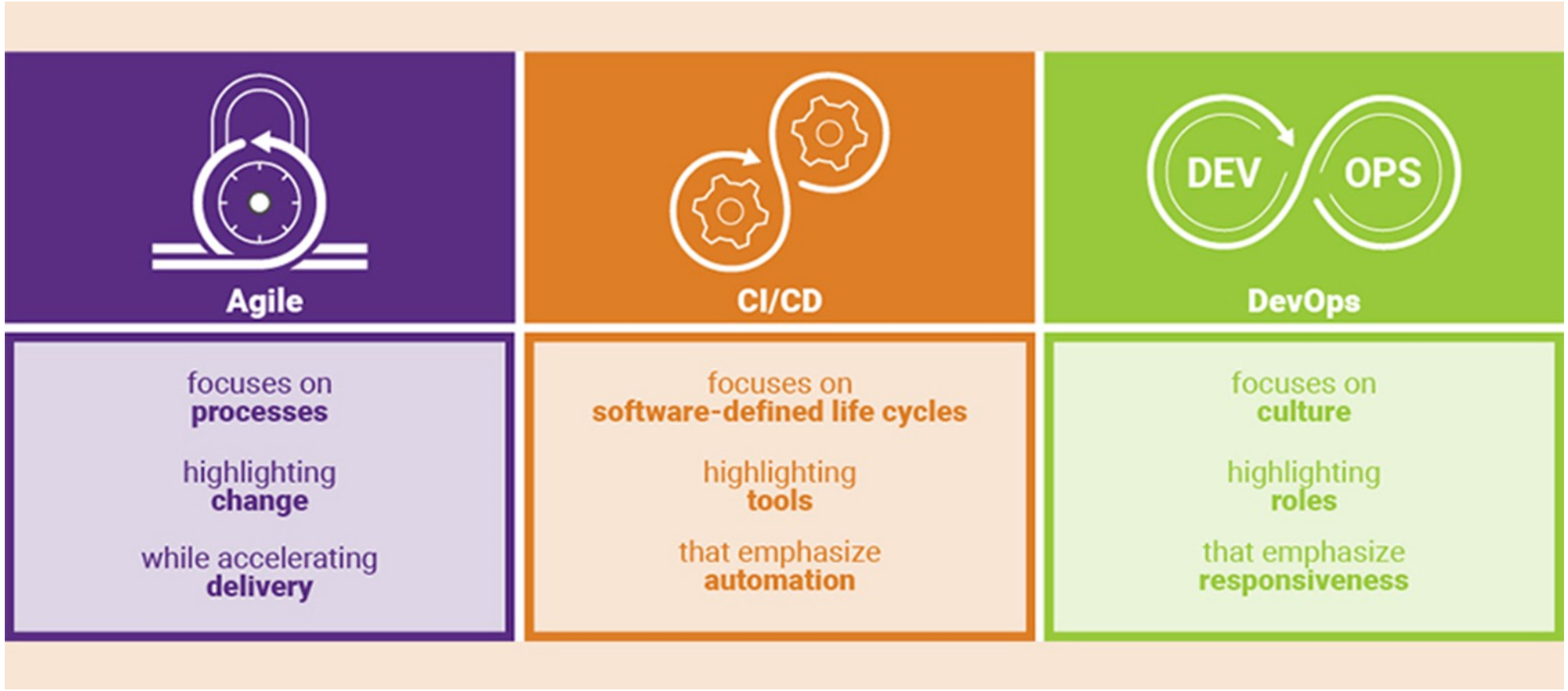
A fool with a tool is still a fool

Martin Fowler

A computer lets you make more mistakes faster than any invention in human history – with the possible exceptions of handguns and tequila

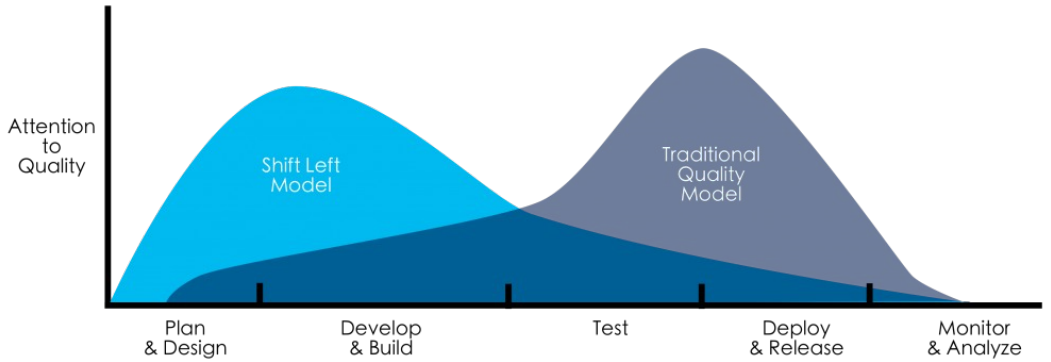
Mitch Ratcliffe

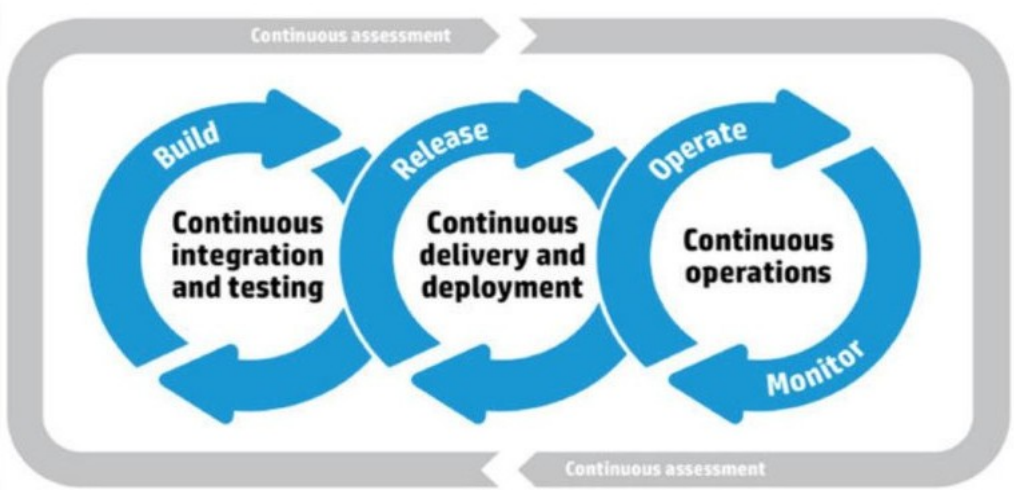
Agile, DevOps and CICD



Continuous Testing

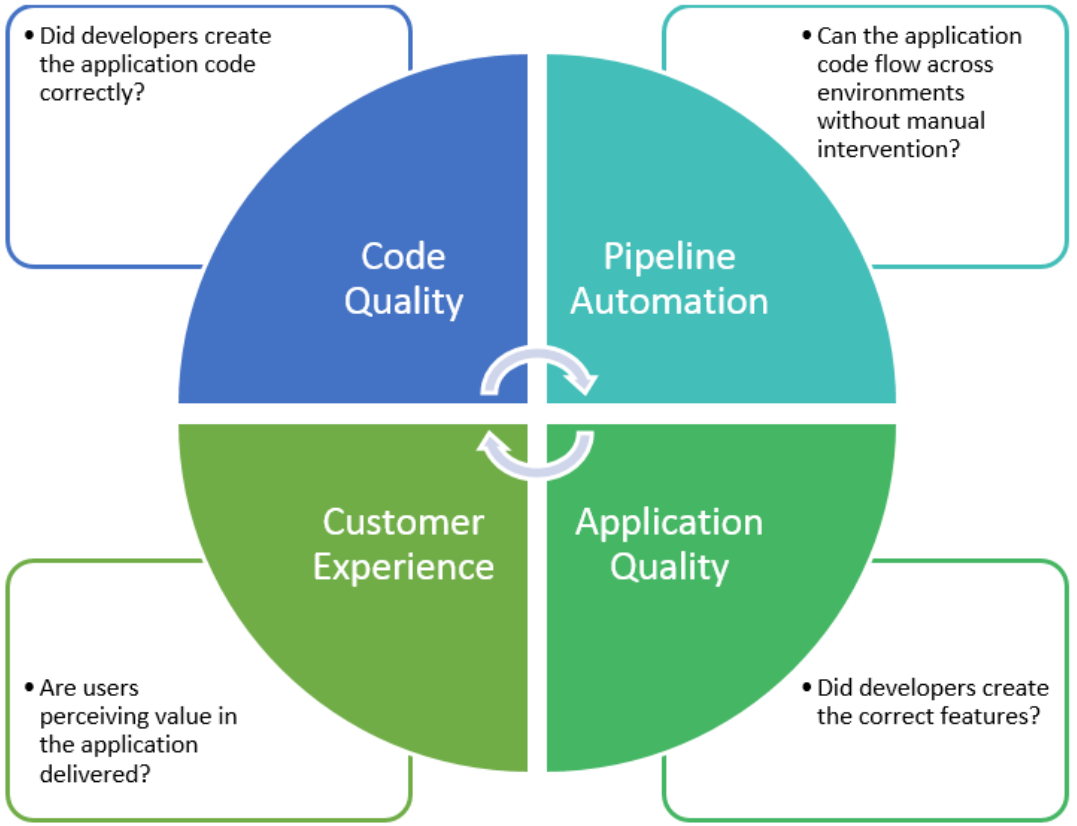
- Continuous Testing
  - Every artifact is tested as it is created
- Shift Left Model
  - Test early, test often
- CICD also adds
  - Automated testing at every stage
  - CT is triggered by events in the CICD process
  - Checking in code => automated unit testing
  - Build => integration testing





Continuous Testing

- Does not replace human based testing
  - Like pair programming and code reviews
  - Creates “quality gates”
- Development pipelines abort when tests fail
  - Adding continuous security testing and security planning is called DevSecOps



Software Engineering Institute

- Commissioned by US Government to find out how organizations built quality software.
- They found it depended on three factors:
  - There was a defined software production process.
  - The organization followed the process when they build software
  - They were always improving the process in terms of efficiency and effectiveness.
- The measure of how much the organization did this was called process maturity

Immature Organizations

- The process is often improvised by the developers and management during the course of the project.
- Defined processes are often not followed or enforced.
- Project activities are reactionary and often focus on solving immediate crises.
- Schedules and budgets are based on unrealistic estimates and routinely exceeded.
- Bringing a project in line with deadlines or costs causes functionally and quality of the product to suffer.
- Product quality is difficult to predict and there are no objective standards to assess product quality.

Immature Organizations

- There are no standard ways for solving problems, everything is done on an “fire-fighting” basis and the same problems keep recurring with the same negative impacts.
- The defined process is not realistic and the organization is characterized by the attitude “Following the process won't get the job done.”
- The defined process is often created in part by those who are not part of the development staff and tends to be more about reporting and management activities than work tasks.

Mature Organizations

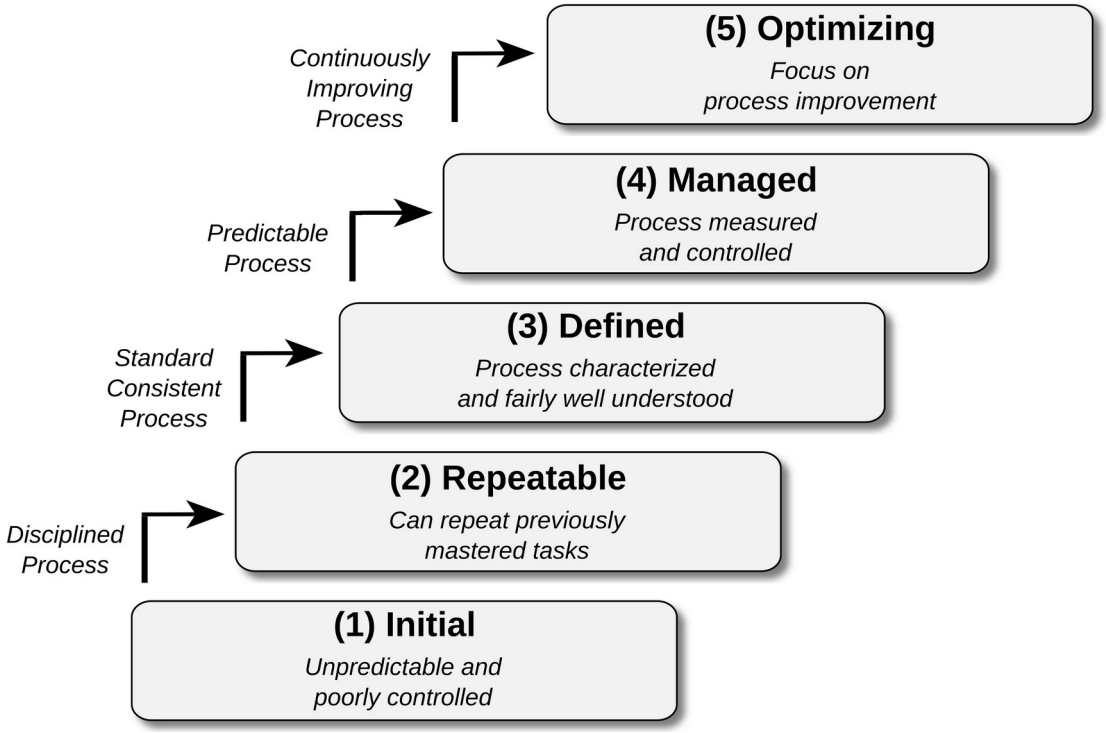
- The software process is standardized across the organization and communicated to all existing staff and new employees.
- All work activities are carried out according to the planned process.
- The processes are usable and realistic because they describe how work actually gets done.
- Defined processes are updated as necessary.
- Improvements to the process are planned and evaluated through pilot tests or cost benefit analyses.

Mature Organizations

- Responsibilities are defined clearly in both the organization and in each project.
- Management continuously monitors the quality of the products and the processes using objective and quantifiable criteria.
- There are defined processes for analyzing and solving problems with the product and process.
- Budgets and schedules are realistic because they are based on historical performance data.
- The infrastructure of the organization supports the process.
- A disciplined process is consistently followed because all of the participants understand the value of doing so and enforce following the process at a peer level.

The Levels

- **Initial**: Basically describes a start-up company – no defined processes
- **Repeatable**: Production process mastered – all projects are on spec, on time and to budget.
- **Encultured**: The process is part of the culture, it's "the way do it here" and is enforced by everyone in the organization.
- **Proactive**: A review based culture – everything is reviewed to ensure it is in alignment with best practices and quality metrics.
- **Integrated**: The processes have become self correcting and prevent non-optimal actions.



The Levels

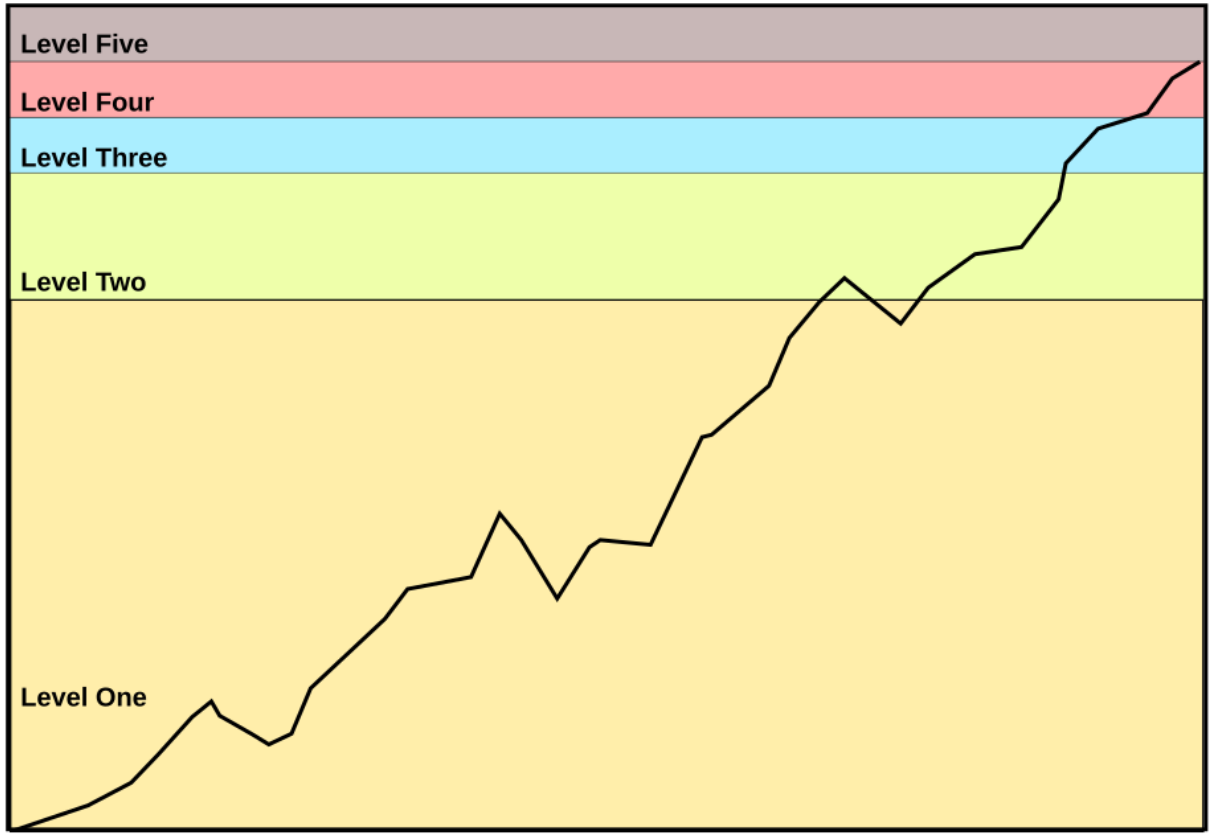
- The levels are benchmark for progress to maturity
- You can’t just decide to be at level 4 for example
  - All of the work at the preceding levels needs to be mastered
- Think of the levels as:
  - Initial. The entrepreneurial level. Innovative and creative
    - Often large companies will start small incubators that are startups to create an environment for new ideas
  - Repeatable. The product has to be delivered consistently on time, on budget and to spec
    - The sign of being at level two is that there are no failed or defective projects, in the language of the chaos report
  - Institutional. There are standard processes
    - The sign of being at level three is that the process is supported and enforced by everyone, not just management
    - If you don’t follow the process, it is your peers that will call you out

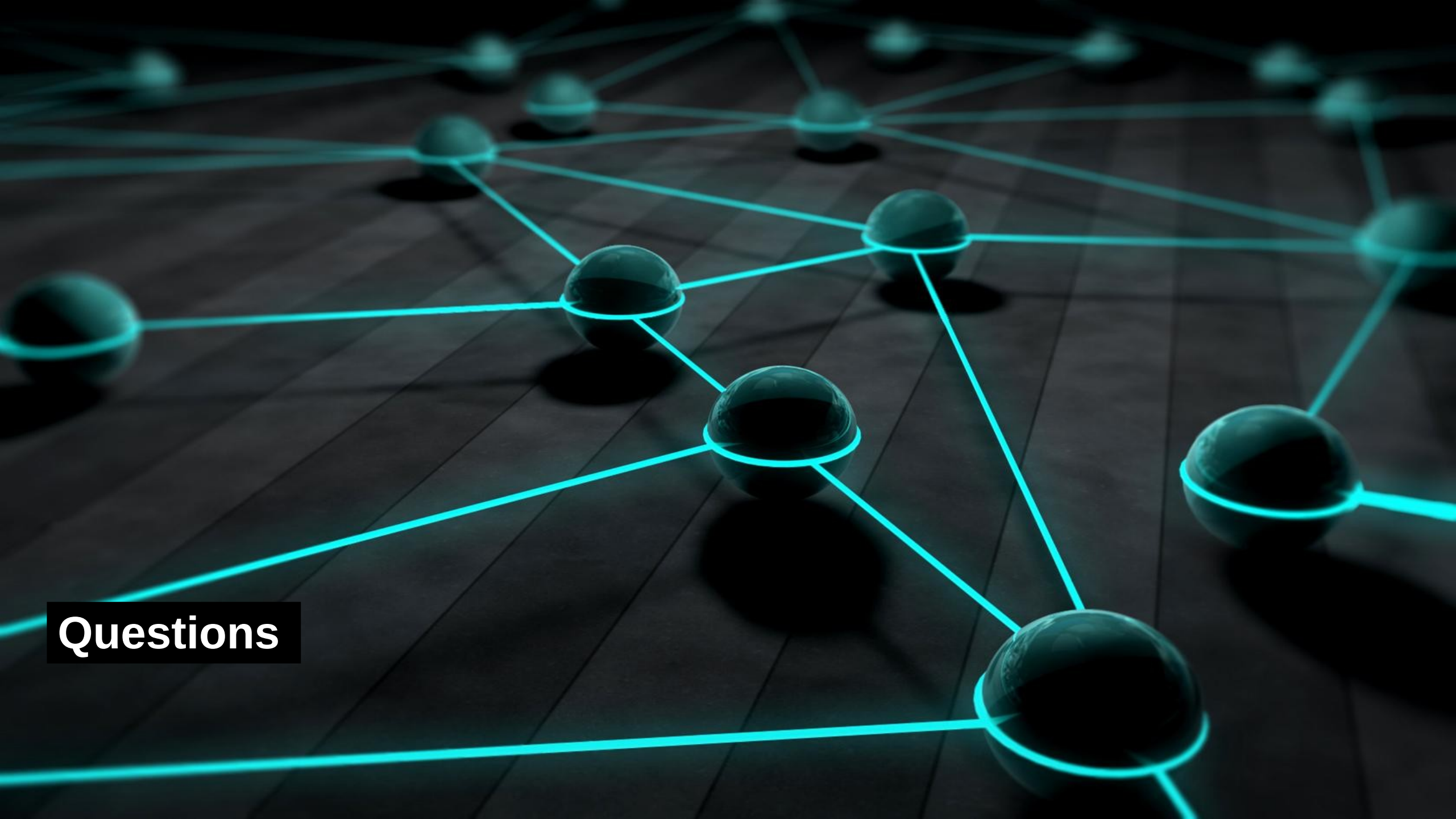
The Levels

- Think of the levels as: (cont)
  - Proactive. From experience, the organization has developed a set of best practices
    - All work is compared to the best practices to proactively find potential problems
    - Often characterized by everything being reviewed (code reviews, design reviews, etc)
    - Best practice standards are constantly updated and improved
  - Integrated. The process is subject to continuous improvement
    - The process is integrated into the day to day activities
    - For example, saving a code file automatically triggers automated testing
    - The process gets better the more it is used.

The Levels

- Some observations
  - It takes years to get to level five, often 10 or more
  - Getting to level two takes the longest
  - Level two requires mastery of all the processes and practices needed to develop software
- Maturity doesn't apply to just software development
  - We can see the same in other production processes for other products or services




Questions